DOCUMENT RESUME

ED 194 522 SP 017 088

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TITLE Student Engagement in Middle School Science Classrooms.
PUB DATE Nov 80
NOTE 23p.: Paper presented at the Annual Meeting of the Southeastern Association for the Education of Teaching of Science (Orlando, FL, November, 1980). For related document, see SP 017 087.

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Academic Achievement; Classroom Environment; *Classroom Techniques; Feedback; *Interaction; Interpersonal Competence; Locus of Control; Questioning Techniques; Reinforcement; Secondary Education; *Student Behavior; *Teacher Behavior; *Teaching Methods; *Time Factors (Learning)

ABSTRACT

Among the teaching variables likely to influence pupil engagement rates are classroom management strategies and instructional behaviors used during presentation of the lesson. Thirteen junior high school science classes were observed to determine how variation in classroom management techniques related to variation in pupil engagement rates, and how rates and types of teaching behaviors related to rates and types of pupil engagement. The relationship between teacher behaviors of attending, recalling, collecting, comprehending, quantifying, planning, and generalizing and pupils' responsive engagement rates was documented. Higher pupil engagement rates were seen to be associated with classrooms in which appropriate classroom behavior was maintained. High engagement rates were also observed in classrooms where the teacher reinforced and encouraged the efforts of learners to maintain involvement, and used teaching methods appropriate for lesson objectives, pupils' cognitive ability, and the classroom environment. (JD)

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STUDENT ENGAGEMENT IN MIDDLE SCHOOL SCIENCE CLASSROOMS

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A paper presented at the annual meeting of the Southeastern Association for the Education of Teaching of Science, Orlando, Florida, November 1980

SP 017 088

STUDENT ENGAGEMENT IN MIDDLE SCHOOL SCIENCE CLASSROOMS

Although considerable research has been conducted on relationships between teacher and pupil behaviors (e.g., Rowe, 1974) there is no clear pattern of the teacher behaviors that promote pupil engagement rates and minimize off-task behavior. Until recently, few studies in science education have focussed on pupil engagement rates as research outcomes. As a consequence, there is little empirical support for recommending or using specific teaching behaviors over others to promote engagement.

Among the teaching variables likely to influence pupil engagement rates are classroom management strategies together with the range of instructional behaviors used as the lesson is presented. For example, higher engagement rates might be expected in well managed classrooms. Indeed, unless satisfactory standards of classroom management are maintained, other potentially important teaching variables such as high quality questioning and an extended wait-time are unlikely to promote pupil engagement or learning. From an intuitive viewpoint there is logical appeal in the statement that teachers can influence pupil engagement rates through the teaching behaviors they use. This paper examines relationships between selected teacher and pupil behaviors in middle school science activities with an emphasis on integrated process skills. The study is a part of a larger set which investigated relationships among teaching behaviors, pupil attributes, pupil engagement and pupil achievement. The model presented in Figure 1 incorporates the hypothesized relationships

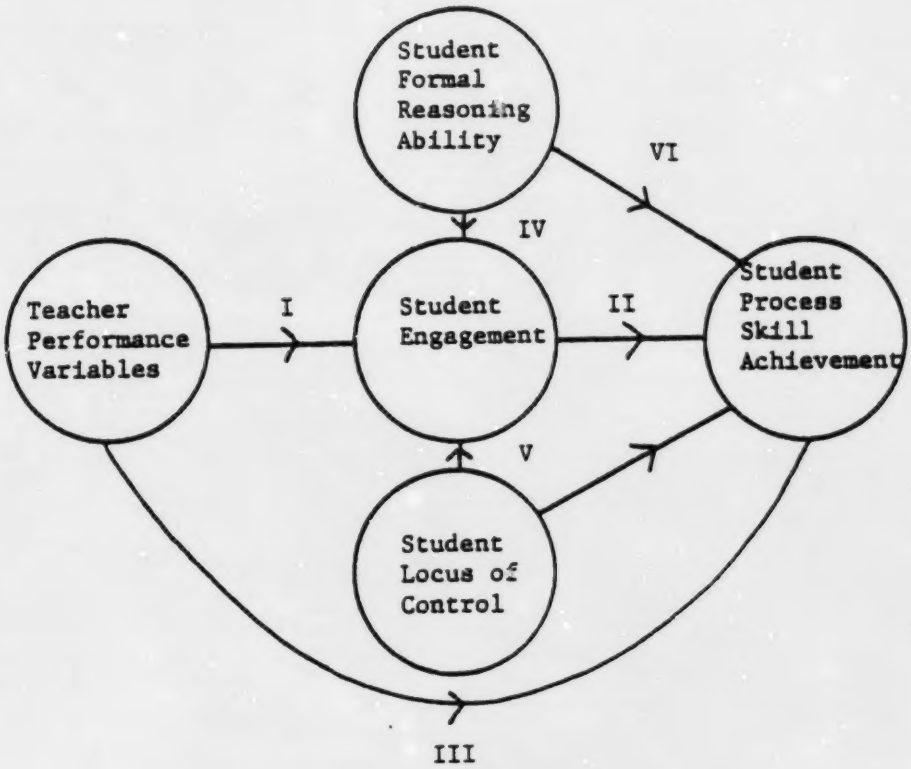

Figure 1. A process-product model for student achievement of science processes.

investigated in the studies. The results of the larger set of studies are reported elsewhere (Tobin and Capie, 1980a, b, c).

Integrated process skills are intellectual skills which are related to collection and interpretation of data. Students can use process skills to formulate responses to questions, to justify points of view, to explain events or procedures, and to interpret or describe results. Since process skill objectives represent higher cognitive skills, the model suggests that pupils need to engage in higher cognitive level behaviors to have appropriate practice on the objectives. Thus, the role of the teacher is conceptualized in terms of structuring the environment to provide learning experiences that allow pupils to maximize academic engagement. Two questions are investigated in this paper:

1. How is variation in classroom management of teachers related to variation in pupil engagement rates?
2. How are rates and types of teaching behaviors related to rates and types of pupil engagement?

PROCEDURES

Thirteen intact classes from four middle schools in Clarke County, Georgia, were selected to participate in the study. Five of the selected classes were from grade 8, four from grade 7, and four from grade 6. The classes participating in the study were heterogeneous with respect to socio-economic status, race, and intelligence. The range on each of these variables within each class was similar for all participant classes in accordance with a policy of heterogeneous grouping that was adopted in the school district. Sixty percent of the sample was from homes of high socio-economic status and 40 percent

from homes of low socio-economic status. Sixty percent of the sample were white, 37 percent black, and 3 percent were of other races.

A sequence of eight science lessons was presented in each class over a two week period of time. Each lesson was developed from a learning hierarchy to promote the acquisition of twelve objectives related to hypothesizing, interpreting data, identifying and controlling variables, and defining operationally (Tobin and Capie, 1980d).

Selection of Subjects

A quasi-random sampling procedure was used to select 12 students from each class as data sources for academic engagement measures. Many of the questions investigated in the larger set of studies required a broad range of formal reasoning ability in the sample to be observed. Thus, within each class, four students were randomly selected from those scoring greater than three on the Test of Logical Thinking (TOLT) (Tobin and Capie, 1981), four students from those scoring two or three, and four students from those scoring less than two. The scores used for stratification were selected on the basis of prior research with middle school students (see Tobin and Capie, 1981). The stratifying procedure was adopted to assure that a satisfactory range of formal reasoning ability was represented in the sample. In classes where less than four students were represented in the highest category, additional students were selected from those scoring two or three on the TOLT.

Classroom Management

All teachers were rated on 25 performance indicators from the Teacher Performance Assessment Instruments (TPAI) (Capie, Johnson, Anderson, Ellett and Okey, 1979). The performance indicators assessed

classroom procedures and interpersonal skills (see Table 1). A generalizability coefficient of .87 indicated that the measures obtained in the study were dependable for differentiating teacher performance. Factor score coefficients from a study involving a large sample of beginning teachers (Capie, Tobin, Ellett, and Johnson, 1980) were used to obtain a measure of classroom management for each teacher in the study. Thus, each performance indicator contributed to a single measure of classroom management.

Objectives-Related Behaviors

Teacher behavior was rated at 30 second intervals throughout each lesson. The predominant behavior to occur within each interval was categorized using Transactions in Science (TIS). Eight behavioral categories were used as a basis for categorization.

Academic Engagement

The behavior of each student was observed for one lesson of every two using a time sampling procedure in which behavior was observed for four seconds during each 30 second interval. If more than one codable behavior occurred in the four second interval, the predominant behavior to occur in that interval was recorded. The order in which students were observed was randomly determined.

Frequency counts constituted the raw data for the analysis. To enable proportions to be calculated for each engagement category, behavior data for each pupil were pooled over the four lessons that were rated. The proportion of time allocated to each mode of engagement was used as the unit for analysis for hypotheses related to student engagement. A generalizability coefficient for differentiating students and generalizing over lessons was estimated for each engagement category (see Table 3).

TABLE 1

Performance Indicators Used to Obtain
Measures of Classroom Management

Performance Indicators	Correlation with Factor	Scoring Coefficient
Uses teaching methods appropriate for objectives, learners and environment.	.83	.084
Uses instructional equipment and other instructional aids.	.61	.031
Uses instructional materials that provide learners with appropriate practice on objectives.	.73	.057
Gives directions and explanations related to lesson content.	.75	.063
Clarifies directions and explanations when learners misunderstand lesson content.	.71	.051
Uses responses and questions from learners in teaching.	.65	.041
Provides feedback to learners throughout the lesson.	.73	.050
Demonstrates ability to conduct lessons using a variety of teaching methods.	.75	.062
Demonstrates ability to work with individuals, small groups, and large groups.	.58	.029
Provides learners with opportunities for participating.	.70	.045
Reinforces and encourages the efforts of learners to maintain involvement.	.82	.079
Helps learners recognize the purpose and importance of topics or activities.	.54	.031
Attends to routine tasks.	.67	.044
Uses instructional time effectively.	.68	.037
Provides a learning environment that is attractive and orderly.	.40	.015

Continued

Performance Indicators	Correlation with Factor	Scoring Coefficient
Communicates personal enthusiasm.	.80	.060
Stimulates learner interest.	.82	.086
Conveys the impression of knowing what to do and how to do it.	.73	.056
Demonstrates warmth and friendliness.	.76	.059
Demonstrates sensitivity to the needs and feelings of learners.	.78	.068
Demonstrates patience, empathy and understanding.	.73	.051
Provides feedback to learners about their behavior.	.75	.052
Promotes comfortable interpersonal relationships.	.74	.050
Maintains appropriate classroom behavior.	.78	.090
Manages disruptive behavior among learners.	.58	.031

TABLE 2

Definitions for Transactions in Science

	Category	Definition
1.	Attending	Looking at the teacher, book, worksheet, paper, chalkboard, etc. Physically attending to a task.
2.	Recalling	Responding to questions with recalled facts. Stating definitions. Stating names and/or terms without explaining their meaning. Stating matters of fact.
3.	Collecting	Collecting data in an investigation. Copying material from books or the chalkboard, etc. Recording data in an investigation.
4.	Comprehending	Explaining the meaning of a term. Naming data points on a graph. Describing graphic or tabular data. Reporting techniques. Reporting data. Representing data in a different mode.
5.	Quantifying	Calculating relations between data. Reducing many bits of data to a representative value. Determining a scale for graphic representation of data. Reducing many bits of data to sub-groups. Classifying data into sub-groups.
6.	Planning	Identifying variables that are relevant to a given problem. Identifying the dependent variable in an investigation. Identifying the variables that may affect the dependent variable in an investigation. Identifying the independent variable to be manipulated in an investigation. Identifying procedures for manipulating the independent variable in an investigation. Identifying the variable to be controlled in an investigation. Identifying procedures for controlling variables in an investigation. Identifying methods of measuring the dependent variable in an investigation. Identifying variables to label the axes of a graph or to be the headings on a table.

Continued

Category	Definition
7. Generalizing	Comparing data from an investigation. Identifying data that support a hypothesis. Interpolating between or extrapolating beyond data points in tables or graphs. Using data to construct an inference. Using data to construct an hypothesis. Justifying an explanation or a decision.
8. Non-cognitive	Non-cognitive behaviors that are goal-directed. (e.g., collecting items of equipment, assembling apparatus)
9. Off-task	Behaviors that are not goal-directed. (e.g., reading a book while the teacher is explaining how to solve a problem)

TABLE 3

Generalizability Coefficients for

Student Engagement Data

Engagement Category	Generalizability Coefficient
Total Engagement	.92
Off-task	.92
Attending	.91
Recalling	.57
Collecting	.89
Comprehending	.70
Quantifying	.25
Planning	.31
Generalizing	.66
Non-cognitive	.36

Data Analysis

The relationships between classroom management and pupil engagement rates were assessed with product-moment correlation coefficients. A multivariate analysis (canonical correlation analysis) was conducted to determine the strength and nature of the relationships between seven teaching behaviors and pupil engagement rates on eight categories.

RESULTS

A correlation of .76 ($p < .001$) between classroom management and class mean pupil engagement rates provided an indication of a strong positive relationship. Of the engagement categories attending was most strongly related with classroom management ($r = .62$, $p < .01$).

Table 4 contains mean engagement rates for teachers and pupils during the study.

The canonical correlation analysis indicated that four dimensions were needed to explain the relationships between the teaching behaviors and rates of pupil engagement. Each teacher and student dimension consisted of a linear composite among the teacher and pupil variables respectively. The canonical correlation coefficients between the corresponding teacher and student dimensions are contained in Table 5. The first four coefficients are statistically significant, however, only three are of practical significance.

Interpretation of each dimension is possible from the correlation of each variable with its associated linear composite. These correlations are contained in Table 6.

Table 7 contains data that indicate how pupil engagement rates varied for each of the teaching behaviors.

TABLE 4

Teacher Behaviors and Rates of Student Engagement

Engagement Category	Mean Teacher Percentage	Standard Deviation	Mean Student Percentage	Standard Deviation
Attending	Not Coded		33.12	14.97
Recalling	3.63	2.56	5.39	5.46
Collecting	21.72	8.33	14.63	8.83
Comprehending	22.26	5.50	4.54	3.79
Quantifying	3.83	2.31	0.51	0.90
Planning	16.55	4.67	0.38	0.72
Generalizing	17.07	5.70	1.10	1.51
Non-cognitive	7.87	5.32	2.92	3.65
Total Engagement	92.82	4.77	62.54	22.50
Off-task	7.18	4.77	37.41	22.50

TABLE 5

Canonical Relationships Between Teaching Behaviors and Pupil Engagement

Canonical Variate	Canonical Correlation	df	Chi-Squared	p
1	.83	56	375.4	.0001
2	.68	42	204.3	.0001
3	.58	30	112.8	.0001
4	.46	20	53.4	.0001
5	.26	12	18.9	.09
6	.23	6	8.6	.20
7	.08	2	.9	.65

TABLE 6

Dimensions Underlying Teaching Behaviors
and Pupil Engagement

	Canonical Variates of Teacher Behavior		
Teaching Behaviors	1	2	3
Recalling	.92	.14	-.17
Collecting	-.48	.73	.10
Comprehending	-.31	-.25	-.73
Quantifying	.02	-.42	.49
Planning	.50	-.16	.18
Generalizing	.14	-.37	.80
Non-cognitive	-.57	-.38	-.56

	Canonical Variates of Pupil Engagement		
Pupil Engagement	1	2	3
Attending	.04	.08	.79
Recalling	.83	.08	.20
Collecting	-.23	.65	.58
Comprehending	-.32	.09	.01
Quantifying	-.39	.03	.19
Planning	.30	.19	.33
Generalizing	-.03	-.41	.62
Non-cognitive	-.41	-.47	.16

TABLE 7

Pupil Engagement Rates Corresponding to each Category of Teacher Behavior

Student Behavior	Teacher Behavior 2 (%)	3 (%)	4 (%)	5 (%)	6 (%)	7 (%)	8 (%)	9 (%)
1. Attending	24	12	31	48	59	55	18	08
2. Recalling	53	01	03	05	05	05	02	04
3. Collecting	01	62	04	02	00	02	15	18
4. Comprehending	01	02	13	03	01	02	03	03
5. Quantifying	00	00	00	12	00	00	00	00
6. Planning	00	00	00	00	02	00	00	00
7. Generalizing	00	00	00	00	00	05	00	02
8. Non-cognitive	01	02	01	00	01	01	25	01
9. Off-task	21	30	49	28	32	30	37	63

DISCUSSION

Two important indicators from the classroom management measure relate to management of learners and the learning environment respectively (see Capie, Tobin, Ellett, and Johnson, 1980). Considerable variation on each of these indicators was evident in the measures obtained from the thirteen teachers in the study. The two indicators are:

1. Reinforces and encourages the efforts of learners to maintain involvement; and
2. Uses teaching methods appropriate for objectives, learners and the environment.

Variation in the first of the above performance indicators occurred when teachers did not respond to learners who were off-task, did not respond positively to learners who participated, and did not vary the nature of classroom activity. Higher pupil engagement rates were associated with classrooms in which teachers attended to the management criteria specified above.

The variation that was evident in the second performance indicator was mainly due to variations in the suitability of the arrangement of materials and furniture in the classroom and in the smoothness of transitions between components of a lesson. Engagement rates tended to be higher when materials and furniture were suitably arranged, and transitions were smooth.

Substantial variation was also evident on a third performance indicator that is a strong component of the classroom management measure: Maintains appropriate classroom behavior. In this case, variation was largely due to the presence in some classes of disruptive pupil behavior and failure of some teachers to use techniques to maintain

appropriate behavior. Engagement rates tended to be higher when teachers used procedures to maintain appropriate behavior.

The data presented in Table 4 show the rates of teaching behaviors and pupil engagement. The most prevalent teaching behaviors (comprehending, collecting, planning, and generalizing) reflected the emphases provided in the lesson plans. Pupil engagement rates were generally high in the study, with rates of covert engagement exceeding rates of overt engagement. For example, the percentage of overt objectives-related pupil engagement tended to be low for categories such as planning and generalizing.

The canonical correlation analysis revealed the presence of four teaching dimensions that were significantly related to four dimensions underlying pupil engagement. The fourth teacher dimension was of no practical importance in this study as it related to a dimension that was closely associated with quantifying which was an infrequently occurring behavior. As a consequence, only three of the teaching dimensions were considered to be of importance.

The first teaching dimension was closely related to recalling behaviors and to a lesser extent planning behaviors. Non-cognitive behaviors, data collecting and comprehending were negatively correlated with this dimension of teaching. There was a strong relationship between this teaching dimension and the first pupil engagement dimension that was also closely associated with recalling and planning. Thus rates of teacher recalling and planning were strongly related to the rates of pupil recalling and planning. This finding indicates that teachers were able to influence pupil engagement, although their major influence was with lower cognitive level recalling behaviors, a secondary, weaker influence was also evident on rates of pupil planning.

The second teaching dimension was closely associated with data collecting behaviors. The results suggest a close relationship between the rate of teacher data collecting and rates of pupil data collecting.

The third teaching dimension to be significantly related to a dimension of pupil engagement was defined by teacher generalizing behavior. The dimension is interesting, for a high negative correlation with teacher comprehending indicates a reciprocal relationship between the two teacher behaviors. The significant relationship of the teacher dimension with the student dimension suggests that higher rates of teacher generalizing behavior were accompanied by higher rates of pupil attending, generalizing, data collecting, and planning. Thus, in classes where teachers interpreted data and endeavored to extrapolate findings to other contexts, increased pupil attending rates were evident as well as increased rates of pupil generalizing, data collecting and planning. Conversely, in classes where teacher comprehending behaviors were used in lieu of generalizing behaviors, negative relationships with the above pupil engagement modes were evident.

The canonical correlation analysis provided strong support for the hypothesis that teacher behavior was closely related to pupil engagement rates.

The data in Table 7 provide additional insights into the relationships between teaching behaviors and pupil engagement. For example, when the predominant teacher behavior was planning, 59 percent of pupil engagement was attending. Only two percent of the time were pupil planning behaviors recorded. Similar trends were evident for all behaviors except for recalling and collecting.

When teacher recalling behaviors were recorded, pupil recalling

behaviors were also recorded for 53 percent of the time. Only 24 percent of pupil behavior was attending in this case. The percentage of off-task behavior associated with recalling was 21 percent, a minimum in this study. Whereas teachers were able to promote pupil recalling and collecting behaviors they did not promote overt engagement on other categories to the same extent. The data indicate comparatively high rates of pupil attending and off-task behaviors for all other types of teacher behavior.

Implications for Research and Teaching

Although a comparatively small number of teachers were involved in the study a strong non-chance relationship was observed between classroom management and pupil engagement. On the basis of the results obtained, science teachers should be encouraged to improve their classroom management skills. The management model identified by Capie, Tobin, Ellett and Johnson (1980) provides a concise set of operational definitions of the major constituents of classroom management and can be used by teacher educators in training programs. Further research is also needed so that the differences between well-managed and poorly-managed science classes may be documented for a range of grade levels and science content areas.

The relative merits of overt engagement versus covert engagement need to be investigated. In this study teachers tended to provide pupils with overt practice on lower cognitive level tasks such as recalling and data collecting. Only limited opportunities were provided for overt engagement on higher cognitive level categories such as planning and generalizing. For example one approach would be to compare achievement of students required to write answers to teacher questions with achievement in classes where oral responses are provided.

The optimal amount of time allocated for data collecting also needs to be investigated. From a psychological perspective, some data collection appears desirable; however, the provision of opportunities to practice objectives-related behaviors is also of importance. In this study the amount of time spent on data collecting activities appeared to be excessive in many instances. Research is needed to establish guidelines for planning and implementing middle school science. Identification of engagement categories that result in increased middle school science achievement is an important research priority that has direct implications for curriculum development, teacher education, and classroom practice.

REFERENCES

Capie, W., Johnson, C. E., Anderson, S.J., Ellett, C.D. & Okey, J.R. Teacher Performance Assessment Instruments. Athens, Teacher Assessment Project, University of Georgia, 1979.

Capie, W., & Tobin, K.G. Pupil engagement in learning tasks: A fertile area for research in science teaching. Journal of Research in Science Teaching, 1981 (in press).

Capie, W., Tobin, K.G., Ellett, C., & Johnson, C. A factor analytic investigation of beginning teacher performance data. Athens, Ga.: Teacher Assessment Project, The University of Georgia, 1980.

Rowe, M.B. Relation of wait-time and rewards to the development of language, logic and fate control: Part I--Wait-Time. Journal of Research in Science Teaching, 1974, 11, 263-279.

Tobin, K.G., & Capie, W. The development and validation of a group test of logical thinking. Educational and Psychological Measurement, July 1981 (in press).

Tobin, K.G., & Capie, W. Effects of teacher wait-time in middle school science. A paper presented at the annual meeting of the American Psychological Association, Montreal, Canada, September, 1980a.

Tobin, K.G., & Capie, W. Relationships between formal reasoning ability, locus of control, academic engagement and integrated process skill achievement. Journal of Research in Science Teaching, 1980b, (in press).

Tobin, K.G., & Capie, W. Relationships of selected dimensions of selected dimensions of teacher performance. A paper presented at the annual meeting of the Mid-South Educational Research Association, November, 1980c.

Tobin, K.G. & Capie, W. Teaching process skills in the middle school. School Science and Mathematics, 1980d, (in press).